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Legal Aspects of Technology Assessment and Systems Analysis in Sustainable Urban Development

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Abstract

Large-scale urban development, not to mention synthetic urbanization, will not remain sustainable absent structural changes to the normative and decision making framework that include rolling technology assessment and systems analysis. Technology policies need to be based on outcomes as well as on significant improvements in complexity management at critical stages of planning and implementation. This conclusion endures even if it requires limiting options of political decision making in open democratic societies through normative structural automatisms. Independent of political trends, social consensus almost everywhere favors a prioritization of energy efficiency, alternative energies, resource recycling, urban farming, cost- and time-effective public transportation, water economy, and extended product life. But public interest-driven decision making processes, legislation, and dispute resolution do not adequately take into account the acceleration of technological innovation on the one hand, and of environmental deterioration on the other hand. This paper exposes fundamental weaknesses and future needs for technology assessment drawing on European, American and global experiences. It highlights challenges to avoid possible crises of legitimacy and anti-technology groundswells of Luddite proportions as well as forgoing groundbreaking opportunities for an open knowledge society based on informed consent rather than state mandate.

Keywords: Sustainable urban development, technology assessment, systems analysis, environmental regulation, policy and procedures.

> "When I say the earth belongs to each generation during its course, fully and in its own right… Then, no generation can contract debts greater than can be paid during the course of its own existence." – Thomas Jefferson, *Letter to James Madison*, 1789

1. Introduction

During 2014, 54% of a global human population of 7.3 billion lived in cities, up from 34% in 1960. This share is expected to grow at a degressive rate of 1.84% p.a. between 2015 and 2020, 1.63% p.a. between 2020 and 2025 and 1.44% p.a. between 2025 and 2030.[1] Notwithstanding the considerable benefits of rural life, the overall balance weighs heavily in favor of accelerated synthetic urbanization or sustainable additions to organically grown historic settlements. Planning and delivering turn-key cities, boroughs, or entire special-purpose municipalities such as company towns that support refineries, sea ports, or airports has grown into a sophisticated profit center for global infrastructure project firms and engineering groups like Siemens.[2] Delivering synthetic livable urbanization has turned into a mega-business with project volumes amounting in each case to many billions of dollars. This development of habitats raises as many challenges as it appears to resolve. In its genesis, it will have to change important aspects of our legal system and routinely apply a host of sophisticated practices, standards and procedures. It also provides a noteworthy example for the increasing integration between cybernetics, big data, mathematical and statistical modeling and forecasting, sociopolitical processes of technology assessment, systems engineering and control. It involves, *inter alia*, applications of artificial intelligence, robotics, hydrogen technology,[3] nuclear technology,[4] geoengineering,[5] ambient intelligence, ubiquitous computing, and nanotechnology.[6] One of the fundamental realizations required for a closer look at the matter is that, as a result of increases in the complexity it engenders, human dependence on technology is bound to become near-absolute, with a wide range of ethical and legal implications that will arise sooner rather than later. Neither fossil fuels nor energy resources overall, nor land resources or nourishment supplies are likely to run out in our lifetimes or in our grandchildren's; nor will nuclear energy realistically be rescinded. The Club of Rome's 1972

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[1] WHO Global Health Observatory, Urban Population Growth, http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/.

[2] *See* Siemens, Green Light for Sustainable Urban Development, http://www.siemens.com/entry/cc/en/urbanization.htm.

[3] *See, e.g.* Sukhvinder P.S. Badwal, Sarbjit S. Giddey, Christopher Munnings, Anand I. Bhatt and Anthony F. Hollenkamp, *Emerging Electrochemical Energy Conversion and Storage Technologies,* 79 Frontiers in Chemistry (2014).

[4] William B. Hurlbut, *Altered Nuclear Transfer: Scientific, Legal, and Ethical Foundations*, 22 J. Contemp. Health L. & Pol'y 458 (2006).

[5] *See generally* Albert C. Lin, *Geoengineering Governance*, 8 Issues Legal Scholarship 1, 2 (2009).

[6] *See* J. Clarence Davies, Woodrow Wilson Int'l Ctr. For Scholars, Oversight of Next Generation Nanotechnology 21 (2009), http://207.58.186.238/process/assets/files/7316/pen-18.pdf; Arie Rip, *Nanoscience and Nanotechnologies: Bridging Gaps Through Constructive Technology Assessment,* Handbook of Transdisciplinary Research 145, 152 (G. Hirsch Hadorn et al. eds., 2008); Albert C. Lin, *Size Matters: Regulating Nanotechnology*, 31 Harv. Envtl. L. Rev. 349, 353-54 (2007); *see also* Douglas A. Kysar, *Ecologic: Nanotechnology, Environmental Assurance Bonding, and Symmetric Humility*, 28 UCLA J. Envtl. L. & Pol'y 201, 208-09 (2010).

predictions of 'limits to growth,'[7] while conceptually entirely correct, did not account for human ingenuity or exponential growth of technological innovation once computational resources became unlocked and their development was largely self-perpetuated in terms of Moore's law. But creation of livable and environmentally sustainable habitats for a safe, sane and satisfied human population in the multimillions in each location has already begun as an industry and will only increase in pace as urban population growth rates continue to multiply. As this happens, a number of grave deficiencies in the legal, ethical and integrative perspectives are uncovered.[8] To think that societies will manage the complexity and challenges of global migration with continued variations of the nation state as we know it, or with a legal system that unquestionably values precedent more than it worries about taking advantage of future opportunities, and that took half a century to even recognize a need for environmental *ius cogens* (even if it has not managed to this day to define sustainable development or to agree on impact targets for the purpose of reducing climate change), is bound to provide its own dire prognosis. As an example, the 2008 financial crisis could have been averted almost in its entirety if, but only if, mechanisms and authority to act on a national, international, and multilateral levels had been put in place in anticipation of, not in belated response to, the events resulting in the most profound loss of confidence in public markets in world history. Thus it is our sociopolitical system and its most significant product, our legal and regulatory system, that will face the greatest pressures to adjust from a reactive to a proactive approach under the new realities created by technology and demographics. Survival of the human race may be endangered less by nuclear Armageddon or by greenhouse gases than by the inability of a large portion of the voting population to imagine situations that can only be addressed if they are adequately provided for– admittedly at great expense, not least in terms of the opportunity costs of funding. Even in not-so-democratic systems, the population still needs to be consulted[9]

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[7] Dennis L. Meadows, Donella H. Meadows, Jorgen Randers, The Limits to Growth (1972) (presenting a computer simulated system dynamics model of exponential economic and population growth under conditions of finite resources, commissioned by the Club of Rome and funded by the Volkswagen Foundation. It solved the problem of simultaneity (*i.e.*, mutual causation) by updating all variables in small time increments with positive as well as negative feedbacks and appropriate time delays structuring the various interactions and control processes). Substantially advanced since, system dynamics-based modeling is used throughout the public and private sectors for policy analysis and design. *See* Michael J. Radzicki and Robert A. Taylor, *Origin of System Dynamics: Jay W. Forrester and the History of System Dynamics,* U.S. Department of Energy's Introduction to System Dynamics, http://www.systemdynamics.org/DL-IntroSysDyn/start.htm.

[8] Daniel Barben et al., *Anticipatory Governance of Nanotechnology: Foresight, Engagement & Integration*, *in* The Handbook of Science & Technology Studies (Edward J. Hackett et al. eds., 3d ed., 2008).

[9] Monika Kurath & Priska Gisler, *Informing, Involving or Engaging? Science Communication in the Ages of Atom-, Bio-, and Nanotechnology*, 18 Pub. Understanding Sci. 559, 568 (2009) (contending that public outreach efforts in Europe with respect to nanotechnology have occurred after major investment decisions were already made and "tend[ed] to limit public engagement to matters of values and social and ethical aspects, rather than to expose expertise to scrutiny"). *See also* Hart Research Assocs., Nanotechnology, Synthetic Biology, & Public Opinion 16 (2009),

because technological change has a foreseeable and likely impact on the public interest with broad societal implications. Even just for the appearance of democratic legitimacy,[10] citizens increasingly need to be informed and educated under dramatic time pressure and in a climate of rapidly diminishing trust,[11] if not to vote in favor of a necessary measure then at least to comply with it without civil disobedience and obstruction.

This essay highlights key aspects of the impending challenges for legal systems everywhere and points to needs, if not proposals, for an expedited upgrade of its functionality.

Sustainability depends on managing complexity by qualitative methods. Quantitatively maximizing or minimizing a single, objectively quantifiable target is essentially a trivial task. The same cannot be said about a multitude of targets requiring value-based balancing as well as trade-offs of conflicting interests subject to society's changing values and preferences. One of the hallmarks characterizing sustainable development is the necessity of such cost-benefit analyses at every step.

Sustainable urban development (SUD), a multidimensional, multipolar, and multiscalar concept, depends on an at least a seven-dimensional matrix of factors:

- Natural resources (renewable and recyclable)
- Financial resources
- Technology and innovation (avoidance of waste by planned obsolescence)
- Legal and regulatory framework (international, national, state and municipal levels)
- Public education, information and compliance
- Supraregional influences (war, migration, large-scale natural disasters)

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http://www.nanotechproject.org/process/assets/files/8286/nano_synbio.pdf (reporting that 90% of respondents believed that "more should be done to inform the public about this research" and that 66% of respondents agreed that the "federal government should regulate this research"). *See further* Maria Powell & Daniel Lee Kleinman, *Building Citizen Capacities for Participation in Nanotechnology Decision-Making: The Democratic Virtues of the Consensus Conference Model*, 17 Pub. Understanding Sci. 329, 341, 344 (2008).

[10] Andy Stirling, *Opening Up or Closing Down? Analysis, Participation and Power in the Social Appraisal of Technology,* Science and Citizens: Globalization & the Challenge of Engagement 218, 220 (Melissa Leach et al. eds., 2005) (discussing rationales for public participation in science and technology matters). *See generally* Jürgen Habermas, Legitimation Crisis 17-24, 95-111 (Thomas McCarthy trans., Beacon Press 1975) and John Rawls, *The Idea of Public Reason Revisited*, 64 U. Chi. L. Rev. 765 (1997).

[11] Jane Macoubrie, Woodrow Wilson Int'l Ctr. For Scholars, Informed Public Perceptions of Nanotechnology and Trust in Government 8 (2005), http://www.pewtrust.org/uploadedFiles/wwwpewtrustsorg/Reports/Nanotechnologies/Nanotech_0905.pdf. *See also* Sheila Jasanoff, Designs on Nature: Science and Democracy in Europe and the United States 265 (2005).

2. Technology Assessment as a Tool and as a Process

"All of science is nothing more than refinement of everyday thinking." – Albert Einstein

Although it may be easier than an accurate weather forecast, technology assessment (TA) still poses major challenges[12] for the study and evaluation of technological innovation's future impact on society. It involves scientific as well as ethical judgment,[13] intellectual property rights,[14] legal and regulatory issues,[15] manufacturing problems,[16] environmental matters,[17] commercial facets,[18] and competitive aspects.[19] After all, it is far from predictable that the most advanced, sophisticated, or elegantly engineered technology will—or should—prevail in the marketplace in a particular instance.[20] The concept of technology assessment evolved over the last five decades in the U.S.[21] and Europe.[22] It can be only a matter of time

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[12] Albert C. Lin, *Technology Assessment 2.0: Revamping our Approach to Emerging Technologies*, 76 (4) Brook. L. Rev. 1 (2011).

[13] Kristin S. Shrader-Frechette, *Evaluating the Expertise of Experts*, 6 Risk: Health, Safety & Env't 115, 117 (1995) (arguing for a right of public participation in risk assessments because they have consequences for public welfare).

[14] *Cf.* Robert Frodeman & Jonathan Parker, *Intellectual Merit and Broader Impact: The National Science Foundation's Broader Impacts Criterion and the Question of Peer Review*, 23 Soc. Epistemology 337, 339 (2009).

[15] Einer Elhauge, *The Limited Regulatory Potential of Medical Technology Assessment*, 82 Va. L. Rev. 1525-1617 (2002); *see also* Stephen McG. Bundy & Einer Elhauge, *Knowledge About Legal Sanctions*, 92 Mich. L. Rev. 261, 267-79 (1993).

[16] Ulrich Beck, Risk Society: Towards a New Modernity (Mark Ritter trans., Sage Publ'ns 1992).

[17] *See generally* Holly Doremus, Albert C. Lin, Ronald H. Rosenberg, Environmental Policy Law (6th ed. 2012).

[18] A. Mark Fendrick & J. Sanford Schwartz, *Physicians' Decisions Regarding the Acquisition of Technology,* Adopting New Medical Technology 76-78 (Annetine C. Gelijns & Holly V. Dawkins eds., ch. 5, 1994).

[19] *See* Daniel C. Esty & Andrew S. Winston, Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage 11, 94-95 (2006).

[20] Richard Sclove, Woodrow Wilson Int'l Ctr. For Scholars, Reinventing Technology Assessment: A 21st Century Model 2-3 (2010), http://wilsoncenter.org/topics/docs/ReinventingTechnologyAssessment1.pdf. *See also* Hart Research Assocs., Nanotechnology, Synthetic Biology & Public Opinion 1 (2009), http://www.nanotechproject.org/process/assets/files/8286/nano_synbio.pdf.

[21] The U.S. agency primarily tasked with Technology Assessment is the Executive Office of the President, Office of Science and Technology Policy. Deborah D. Stine, Cong. Research Serv., RL 34736, The President's Office of Science and Technology Policy (OSTP): Issues for Congress 5-7, 24-25 (2009), *available at* http://ncseonline.org/NLE/CRSreports/09Mar/RL34736.pdf. The OSTP, in turn, receives external advice from the President's Council of Advisors on Science and Technology (PCAST) whose membership is selected from industry, education, research, and NGOs in other areas. PCAST conducts workshops and convenes technical advisory groups that could conceivably perform certain functions key to technology assessment. *Id.* at 9, 24-25. From

until its purpose of ensuring a measure of scientific integrity and objective, forward-looking analysis of known lines of innovation[23] will have to be formally recognized by virtually every major government worldwide. However, arguably, R&D and industry trends are so global in nature that the significance of national influence is on the wane. TA has become an indispensable tool of technology policy and of effective regulation.[24] Efforts to control R&D are subject to the *Collingridge dilemma*: while large-scale impacts cannot be adequately identified, weighed, or even predicted before the technology is already extensively developed, commercialized, and widely used, control or change becomes increasingly difficult the more entrenched the technology in question has become.[25] Typically, TA is not, and arguably should not be, locally or nationally parochial; however, TA should take a global outlook that is cognizant of broader consequences and impacts on society that are not commonly

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1972-1995, a Congressional Office of Technology Assessment existed but was de-funded as an 'unnecessary agency' under Newt Gingrich's 'Contract with America.' Robert M. Margolis & David H. Guston, *The Origins, Accomplishments, and Demise of the Office of Technology Assessment*, Science and Technology Advice for Congress 53, 66 (M. Granger Morgan & Jon M. Peha eds., 2003). Its function was later assumed by the Center for Science, Technology and Engineering (CSTE), the Technology Assessment unit of the U.S. Government Accountability Office (GAO). *See* M. Granger Morgan & Jon M. Peha, *Analysis, Governance, and the Need for Better Institutional Arrangements*, Science and Technology Advice for Congress 3, 11 (M. Granger Morgan & Jon M. Peha eds., 2003); and Jon M. Peha, *Science and Technology Advice for Congress: Past, Present, and Future*, 24 Renewable Resources J. 19, 20-21 (2006).

[22] For example the European Parliamentary Technology Assessment (EPTA) network; the European Parliament's Science and Technology Options Assessment (STOA), Brussels; Parliamentary Office of Science and Technology (POST), London; Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques (OPECST), Paris; Institute for Technology Assessment and Systems Analysis at Karlsruhe that operates TAB, the Office of Technology Assessment at the German Bundestag; TA-SWISS, the Swiss Center for Technology Assessment; Institute of Technology Assessment (ITA) of the Austrian Academy of Sciences, Vienna; Norwegian Board of Technology; Danish Board of Technology; Committee for the Future, Helsinki; Parliamentary Evaluation and Research Unit, Stockholm; Biuro Analiz Sejmowych (BAS), Warsaw; Rathenau Institute at The Hague. *See also* Rinie van Est, *The Rathenau Institute's Approach to Participatory TA*, TA-Database-Newsl. (Institut für Technikfolgenabschätzung und Systemanalyse, Oct. 2000), 13, 18, http://www.itas.fzk.de/deu/tadn/tadn003/vest00a.pdf; Reinhard Coenen, *The legacy of the Studiengruppe für Systemforschung*. 44 (2) Minerva 143 (2006); and Lars Klüver et al., European Participatory Technology Assessment 173 (2000), http://www.tekno.dk/pdf/projekter/europta_Report.pdf (observing that "the inequalities and uncertainties attached to scientific-technological developments . . . call[ ] for more inclusive social policy analysis and decision-making").

[23] *See* Arie Rip *et al.*, *Constructive Technology Assessment: A New Paradigm for Managing Technology in Society*, Managing Technology in Society: The Approach of Constructive Technology Assessment 1, 2 (Arie Rip et al. eds., 1995). *See also* Johan Schot and Arie Rip, *The Past and Future of Constructive Technology Assessment,* 54 Technological Forecasting & Soc. Change 251-268 (1997).

[24] Sheila Jasanoff, Designs on Nature: Science and Democracy in Europe and the United States 265 (2005) ("In the United States, a preferred method for displaying objectivity in public decisions has been to clothe the reasons for allocative choices as far as possible in the language of numbers.").

[25] David Collingridge, The Social Control of Technology 17-19 (1980).

realized by scientists, and are characteristically ignored by their financial backers while R&D continues as a work-in-progress. Today, TA is used in different jurisdictions in a broad variety of forms and concepts: as a legislative function; classical or expert TA performed by scientific or technical experts; participatory TA involving obvious and conceivable stakeholders; constructive TA that feeds back findings into the technology design process; or discursive TA aiming at a holistic socioeconomic policy dialog within society about cost-benefit, legitimacy, and desirability. In all its functions, however, TA connects developments in science and technology with the decision making processes in society (including legislative and adjudicative processes, but also in a general, consensus-building discourse).

3. Need for Use of Systems Analysis and Cybernetic Tools under Increased Complexity

At its core, sustainability is about avoidance of waste and optimized use of resources through complex adaptive regulatory systems that form part of any human settlement. Cybernetics[26] involves a circular causal relationship where a system forms part of a closed signaling loop: action by the system causes change in its environment; that change in turn produces some effect on the system through feedback; this, then, causes the functioning or future actions of the system to change or adjust. It is a process that involves both chaos and order on multiple levels. Functional system behavior includes communication, connectivity, cognitive methods, learning, adaptation, emergence, efficiency, efficacy and social control. Cybernetic[27] tools, in particular process controls based on forecasting and feedback, employ mathematical and statistical modeling. The structure of any system, with its numerous circular, interlocking, sometimes time-delayed relationships among complex components, is just as important in determining system behavior as the individual components themselves. An urban environment appears as an open, self-organizing dynamic system where each subsystem adapts to the environment created by all other subsystems.[28] In fact, urban dynamics was the first non-corporate application of computational system dynamics technology.[29]

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[26] Kevin Kelly, Out of Control: The New Biology of Machines, Social Systems and the Economic World (1994, 2014).

[27] Contributors to the cybernetic approach include, *inter alia*, André-Marie Ampère, W. Ross Ashby, Gregory Bateson, Karl Ludwig von Bertalanffy, Stafford Beer, Julian Bigelow, Herbert Brün, Bruce Buchanan, Fritjof Capra, Louis Couffignal, Peter Corning, Felix von Cube, René Descartes, Jeff Dooley, Charles A. Fink, Heinz von Foerster, Jay Forrester, Frank Honywill George, Ernst von Glasersfeld, Viktor M. Glushkov, John H. Holland, Erich Jantsch, Immanuel Kant, Ilya Prigogine, Georg Klaus, Andrey N. Kolmogorov, Chris Lucas, Niklas Luhmann, Humberto Maturana, Warren McCulloch, Marshall McLuhan, Margaret Mead, John von Neumann, Michael O'Callaghan, Paul Pangaro, Talcott Parsons, Gordon Pask, Andrew Pickering, Anatol Rapoport, Larry Richards, Alan Scrivener, Bronislaw Trentowski, Alan Turing, Francisco Varela, Norbert Wiener and James Wilk.

[28] W. Ross Ashby, *Principles of the Self-Organizing System*, 6 (1-2) E:CO 102-126 (1962, 2004), *available at* http://csis.pace.edu/~marchese/CS396x/Computing/Ashby.pdf.

[29] Radzicki and Taylor, *supra* note 7.

Modeling and forecasting techniques have advanced significantly, with the benefit of some generations of systems engineering and systems dynamics invested in its current state of the art. This can be seen in the improved accuracy of weather forecasts, economic projections, and corporate estimates, among other prognostic statements. Modeling and forecasting are still far from exact sciences, yet the accuracy achieved today is surprising in many instances. Nevertheless, the transmission mechanisms for socio-political feedback do, in most cases, lag decades behind: political, legal, regulatory and educational transmission instruments do not work as they ought to in order to allow meaningful use of them as effective cybernetic tools.

As an example, the adjudication of statistical events on a unitary, individualized basis, taking into account the gamut of the substantive and procedural rights of every party (and thus conveying to each such stakeholder *de facto* a limited veto power), cannot lead to either a time-efficient or a cost-efficient result. Both time-efficiency and cost-efficiency also need to be balanced against the supposedly superior quality of individualized adjudication, especially when taking procedural economy and litigation cost as additional categories into consideration. To handle dozens, hundreds, or even many thousands of similarly situated claims in accordance with class action rules is an option, but not a very good one. Arbitration tends to be more flexible in adjusting to the specifics of a case in issue but it also tends to favor more economically resourceful parties. A better option would be a procedure similar to insurance adjustment in cases of mass calamities because this approach permits focusing on elements common to all similarly situated cases without distraction by fact-finding in the individual case. From a cybernetic viewpoint of systems theory, the purpose of legislation, regulation and adjudication is to provide the most accurate feedback to the operational system at lowest cost in the shortest time. It is clear that the current system fails all these criteria: in addressing complexity, all the world's major legislative and legal systems, being largely precedent-oriented and therefore looking backwards instead of seeking to anticipate potential developments, rely only in small part on collective intelligence and self-organization to produce emergent behavior.

4. Managing Finite Natural and Financial Resources

"[A] man … knows that the world is not given by his fathers, but borrowed from his children."[30]

Sustainability is closely tied to resource management. If man is meant not to use up more than he can return, an optimization challenge needs to be resolved that includes maximization of recycling, re-use, and energy efficiency on the side of savings. This optimization challenge also requires a cost-effective increase in creating additional knowledge and innovation. Given imminent demographic realities, it will be implausible to save our way out of existing constraints and resource limitations. In the words of Senator Mark Udall: "Our livelihood is intimately tied to the food we

[30] Wendell Berry, The Unforeseen Wilderness: An Essay on Kentucky's Red River Gorge 26 (1971).

eat, water we drink, and places where we recreate."[31] Renewable and recyclable resources have already coined the term *urban engineering*, which describes the professional tasks of recovering recyclables from the city's obsolete elements to put them toward infrastructure and services.[32] Management of such materials is an economic optimization task largely resolvable by the tools that science, technology, and operations research already provide. At the core of the optimization challenge is a reality created by prevailing accounting standards: contemporary industrial production is not geared toward preserving natural resources, but toward financial efficiency. As a result, a commodity that is cheap today due to temporary market forces will not be prioritized for preservation. Not least because of their growing share of human population, urban areas represent the heaviest drain on non-renewable natural resources. Still, by far more challenging than management of materials are the political choices concerning allocation of scarce financial resources. After all, "[g]overnment is a way by which every individual believes he can live at the expense of everybody else."[33] Analysis and planning rely largely, albeit with exceptions, on the assumption of *ceteris paribus* and *rebus sic stantibus*, that is to say, on continuation of circumstances prevailing or foreseeable at the time of forward-looking observations. This approach is bound to fail because, if anything can safely be assumed to be a virtual certainty, it is the fact that things will *not* stay as they are. But because neither direction nor degree of change can be predicted meaningfully beyond a certain event horizon, this principle reflects lack of alternatives rather than a rational assumption. Still, the aftermath of the 2008 financial crisis and its consequences for debt-based credit ratings of nations and their public finances demonstrated the need to curb budgetary sovereignty by rescinding politicians' ability to buy re-election through promises of populist spending that would harm future generations, since at least a fraction of those promises will have to be fulfilled at attendant cost. One key measure of sustainability is the indefinite maintenance of processes by replacing resources consumed with resources of equal or greater value and without endangering the system. Unmanageable risks tend to arise out of public guarantees: in the U.S., this happened *inter alia* by way of federal statutory guarantee of Savings & Loan institutions, by FNMA and GNMA mortgage lending, and, with losses yet to materialize, in the case of SLM Corporation (Sallie Mae student loans have long kept many unemployable students off the unemployment rolls at the price of future indentured debt servitude), by allowing bipartisan political misuse of the Social Security Trust Fund, but also by way of continuous congressional 'pork' spending–a central reason why the line item veto was never and will likely never be accepted by any Congress. By definition, governments spend other people's money. Whenever proposals of automatisms such as spending or debt limits are introduced or their enforcement is attempted, populist argument invariably appeals to emotional knee-jerk reflexes by opposing 'cold', 'soulless', 'robotic' mechanisms said to exclude 'political judgment.' This ritual will always present dramatic examples of why

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[31] Senator Mark Udall on Earth Day, April 22, 2012, http://www.markudall.senate.gov/?id=2179&p=blog.

[32] Ian Jenkinson, *Municipal Engineer – the silver anniversary*. Proceedings of the Institution of Civil Engineers, 162 (2) Municipal Engineer 65-68 (June 2009).

[33] Milton Friedman, *Presidential Report Card*, Uncommon Knowledge, Feb. 10, 1999, *available at* http://www.hoover.org/research/presidential-report-card-milton-friedman-state-union.

spending discipline would produce one or the other heart-wrenching and 'unconscionable' result. Yet, the complex needs for sustaining funding of a community's numerous balanced sub-systems—such as education, arts and culture, science and research, infrastructure, elder care, health care, environmental concerns, energy choices, the list goes on—are always first to be cut when elected officials, under bond market pressure, declare 'austerity' to be society's paramount survival need. While this claim is, in large measure, inaccurate, resulting from accounting standards that ignore most intangible values, it helps politicians avoid or delay measures that would be likely to affect their re-election within limited terms of office. Examples include raising the retirement age, lowering pension benefits and other mass entitlements, or declining bail-outs for recklessly managed industries—all items that, due to their large aggregate funding needs, would be the only path to significantly affecting the bottom line. As Milton Friedman noted,[34] the only way to save taxpayers from periodic disasters caused by their elected representatives is to deprive those representatives of the power of the purse, be it through constitutional automatisms, judicial review, or some mechanism of expert intervention. Significantly, most nations have an attorney general, a solicitor general, a surgeon general, an independent central bank—but hardly any society affords an 'accountant general' or court of accounts with adequate powers. Processes such as SUD have no politically significant lobbies to date. Budget cuts often do not affect the individual noticeably until years later, and even then not in a readily demonstrable causal nexus that matters enough to voters to mobilize them for a show of mass discontent. This is all the more true of cuts across the board. As in many political or executive decisions, there is almost always a clearly predictable winner in any conflict between short-term and long-term interests, between simple solutions and complex reality. This predictability results from the education of the audience, the effect of mass media, and, most importantly, man's decreasing attention span and susceptibility to rhetoric denying proof of a confirmable nexus between present cause and future effect.

5. Sustainability as Economic Core Value Inherent in Technology and Innovation

The human mind's creativity and its ability to generate intellectual property counts among the few infinitely renewable resources. Planned obsolescence, *i.e.*, the

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34 "You would rather have people who have a presumption against government expansion but that won't protect you. It's only the people who can protect you by cutting taxes and taking away the dollar from the government." Milton Friedman, *The Economic Impact of the War on Terrorism*, Uncommon Knowledge, Sept. 25, 2001, *available at* http://www.hoover.org/research/economics-and-war-economic-impact-war-terrorism. Perhaps it is worth contrasting with some other of Friedman's memorable pronouncements: "I say thank God for government waste. If government is doing bad things, it's only the waste that prevents the harm from being greater." The Open Mind (1975), https://www.youtube.com/watch?v=STFJZtRmpvs and "Nobody spends somebody else's money as carefully as he spends his own. Nobody has the same dedication to achieving somebody else's objectives that he displays when he pursues his own." *From Cradle to Grave*, Free to Choose (1980), https://www.youtube.com/watch?v=eJFSLACxFkk.

artificial limitation of useful product life to limit its functionality or fashionable desirability past a given period, a practice presently entirely legal in the U.S., was reclassified by statute as a form of consumer fraud in France,[35] a concept likely to influence legislation throughout the European Union and elsewhere in due course,[36] assuming that predicted conceptual weaknesses of this legislation (regarding plaintiff's burden of proof, correlation with price, legitimacy of consumer expectations) do not develop into a deterrent. In the 1920s, major global lightbulb manufacturers including Osram, Philips, and General Electric entered into a secret agreement to reduce the quality and thus the life span of their bulbs (the *Phoebus cartel*).[37] A decade later, around 1935, DuPont discovered that the first pantyhose had a nearly unlimited lifespan. DuPont ordered its product designers to change that.[38] Laser and inkjet printers sold by HP, Canon, Epson and Brother contain a chip that counts pages. After a certain number is reached, the chip renders the printer dysfunctional and forces the customer to request maintenance—consisting of a technician inserting a code that resets the page counter chip—for a fee.[39] Many consumers, on the other hand, will not bother with repair but will instead replace the product altogether: a manufacturer's dream. Digital technology has turned consumer goods into an environmental catastrophe because it is increasingly easier to program planned defects, while it is almost impossible to prove that this is the case. Manufacturers intentionally make repairs as complex and costly as possible to force product replacement as a more cost-effective alternative under the circumstances. In many cases, repair instructions are kept secret (Apple is a notorious example[40]) and individuals uploading them online face lawsuits. Some manufacturers design their

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[35] *See* Loi n° 2014-344 du 17 mars 2014 relative à la consommation, *available at* http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000028738036&categorieLien=id.

[36] *See* Anneli Jäätteenmäki, MEP, Parliamentary question for written answer to the Commission under Rule 117, http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+WQ+E-2011-004273+0+DOC+XML+V0//EN.

[37] Patrick Gaughen, *Structural Inefficiency in the Early Twentieth Century: Studies in the Aluminum and Incandescent Light Markets*, Soc. Sci. 610, Dec. 1998, *available at* http://web.archive.org/web/20050204082354/http://www.andover.edu/aep/papers/610/pgaughen98.pdf. The generalized argument that longer life spans result in wasteful energy consumption is as misleading and unsupported by evidence as the concept that shorter life spans are a natural result of pricing pressures in consumer markets – a cheap product supposedly cannot possibly last as long as an upscale one. This falsely implies a rigid nexus between sales price and production cost.

[38] Jennifer S. Li, The Story of Nylon, http://kaufmann-mercantile.com/nylon/. *See also generally* Giles Slade, Made to Break – Technology and Obsolescence in America (2007); Vance Packard, The Waste Makers (1960, 2011).

[39] Jason Beam, *Designed to Fail: Planned Obsolescence in Printers*, Reports from Earth, http://www.reportsfromearth.com/155/designed-to-fail-planned-obsolescence-in-printers-tricks-to-fix-them/ *See also* Pyramids of Waste. Planned Obsolescence Documentary (2010), https://www.youtube.com/watch?v=ViI6uAxqEOY.

[40] Kyle Wiens, *The Shady World of Repair Manuals: Copyrighting for Planned Obsolescence*, Wired, Nov. 12, 2012, *available at* http://www.wired.com/2012/11/cease-and-desist-manuals-planned-obsolescence/

products to make battery replacements impossible.[41] While Henry Ford steadfastly resisted proposals aimed at limiting product life span, planned obsolescence emerged at the same time as the mass manufacturing that he pioneered. This correlation is no coincidence—a product that refuses to die is deemed a tragedy for business (and, by extension, for organized labor). There were even ultimately unsuccessful legislative attempts during the Great Depression to make planned obsolescence mandatory as a means to secure employment and return on capital.[42] Planned obsolescence has been at the heart of consumer society since the 1950s and became a core emphasis of engineering and industrial product design. It is an instrument to promote growth in excess of the rate naturally necessitated by technology and demographics. As a result of planned obsolescence, shiploads of electronic waste (declared for customs as 'second hand goods') are carried from industrialized countries to the Third World, creating vast environmental problems with grave consequences.[43] From a legal perspective, planned obsolescence forces consumers to choose innovation over low cost of ownership and lengthy product life cycles, effectively depriving them of a choice arguably based on justified expectations. Planned obsolescence is part of a post-WWII concept that challenges the finality of ownership by associating it with ever-increasing streams of expenses that result in a total cost of ownership over the asset's life span that is very different from the initial purchase price. Other examples of this trend can be observed in the taxation of property or its use (*e.g.,* taxation of digital communication), and in increasingly routine software engineering and product support policies that have, for all intents and purposes, turned an asset that was once 'owned' into the functional equivalent of a rental, creating a constant future stream of income for the seller/licensor, the net present value of which can become a central aspect for the seller/licensor's stock market valuation.

However, rethinking production processes and methods showed in countless instances that it is entirely possible to redesign and avoid toxicity along with other aspects of environmental footprint without significant adverse effects on productivity, functionality, design, or price. It is primarily a matter of the priorities expressed in regulatory requirements, not one of feasibility or of aversion to innovation or technological progress, that limits increases in technological sustainability.

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[41] Jens Lubbadeh, *Die Reparatur-Rebellen*, Tech. Rev., Sept. 4, 2013, http://www.heise.de/tr/artikel/Die-Reparatur-Rebellen-1935015.html.

[42] Serge Latouche, Bernard London, ou la planification de l'obsolescence à des fins sociales (2003).

[43] *Toxic 'e-waste' dumped in poor nations, says United Nations*, The Guardian, Dec. 14, 2013, *available at* http://www.theguardian.com/global-development/2013/dec/14/toxic-ewaste-illegal-dumping-developing-countries; Mike Ives, *In Developing World, A Push to Bring E-Waste out of Shadows.* Environment 360, Feb. 6, 2014, http://e360.yale.edu/feature/in_developing_world_a_push_to_bring_e-waste_out_of_shadows/2736/.

6. Supraregional Influences and Challenges to Urbanization

Aside from Black Swans [44] such as war and lower-level military and paramilitary confrontations, continuing migration and large-scale natural disasters such as earth quakes, river floods, tsunamis, volcanic activity, tropical storms and rising sea levels present the greatest challenges to SUD because of the resulting disproportionate financial dislocations. Migration has reached spectacular dimensions: about one billion individuals or about one-seventh of the planet's human population (214 million international migrants and approximately 740 million internal migrants) roamed the world in 2009.[45] Until the ascendancy of the nation state in the 17th and 18th centuries, and *de facto* well beyond that time until the universal introduction of passports, freedom of movement was, if not always recognized as a defined political right, at least treated as a natural right.[46] It eventually became formally recognized as one of the four freedoms of movement (of goods, services, labor and capital) fundamental to the *acquis communautaire* of the European Union, if only among its member states.[47]

7. Legal and Regulatory Framework at the International, National, State and Municipal Levels

"If you intend to drain a swamp, you should not consult the frogs."[48]

The fact remains that frogs are almost the only ones to be consulted reliably. In Western democratic systems (although not only there), regulators and regulations are predominantly influenced by lawyers, consultants, and lobbyists—professionals that are typically retained by the targets of the intended regulation. As a result,

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[44] An event or occurrence that deviates beyond what is normally expected of a situation and that would be extremely difficult to predict. http://www.investopedia.com/terms/b/blackswan.asp.

[45] Brad K. Blitz, Migration and Freedom – Mobility, Citizenship and Exclusion 1 (2014) (citing United Nations Population Division, International Migrant Stock: The 2008 Revision Population Database (2009), http://esa.un.org/migration and Martin Bell and Salut Muhidin, Cross-National Comparisons of Internal Migration (Human Development Research Paper, 2009), http://hdr.undp.org/fr/content/cross-national-comparisons-internal-migration.

[46] Satvinder S. Juss, International Migration and Global Justice 11 (2013). *See also* Alan Dowty, Closed Borders: The Contemporary Assault on Freedom of Movement (1989); Jonathon W. Moses, Migration: Globalization's Last Frontier (2006); Frederick G. Whelan, *Citizenship and Freedom of Movement: An Open Admission Policy?* Open Borders? Closed Societies? 3-40 (Mark Gibney ed., 1988).

[47] Consolidated Version of the Treaty on the Functioning of the European Union art. 45, 2008 O.J. C 115/47 (name changed by the Treaty of Lisbon from Treaty of Rome, March 25, 1957, 298 U.N.T.S. 3, 4 Eur. Y.B. 412) (TFEU).

[48] For experience from Dodd-Frank regulatory efforts directly applicable to this matter *see* http://www.marketplace.org/topics/business/economy-40/dodd-frank-if-you-want-drain-swamp-dont-ask-frogs.

international law on the subject of sustainable development is still largely aspirational, non-binding, unspecific, and focused on establishing broad common principles for a baseline consensus that is largely summed up in declarations of diplomatic or ILA conferences, most importantly the Stockholm Declaration of 1972,[49] the World Charter for Nature of 1982,[50] the Rio Declaration of 1992,[51] the Johannesburg Declaration of 2002,[52] the New Delhi Declaration of 2002,[53] and the Sofia Declaration of 2012.[54] While their character as international *opinio iuris*, much less as *ius cogens,* remains controversial and their enforceability is subject to a variety of caveats regarding international legal norms (with the debate over sources of international law still undecided[55]),[56] these declarations have distilled seven general principles[57] that have become recognized over a half-century and in due course were implemented by international tribunals[58] to a tentative and halting[59] but nonetheless increasing degree:

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[49] Report of the United Nations Conference on the Human Environment, A/CONF. 48/14, 2-65, and Corr. 1, Stockholm, June 16, 1972, 11 Int'l Legal Mats. 1416-69 (1972).

[50] World Charter for Nature, A/RES/37/7, Oct. 28, 1982, a non-binding resolution of the U.N. General Assembly. The only vote in opposition was cast by the United States, with 18 abstentions.

[51] Declaration on Environment and Development, A/CONF.151/26 (Vol.1), Rio de Janeiro, June 14, 1992.

[52] Declaration on Sustainable Development, A/CONF.199/20, Chapter 1, Resolution 1, Johannesburg, Sept. 4, 2002.

[53] New Delhi Declaration of Principles of International Law Relating to Sustainable Development, ILA Resolution 3/2002, UN Doc A/57/329, International Environmental Agreements: Politics, Law and Economics 2: 211-215, New Delhi 2002.

[54] Sofia Declaration, ILA Resolution 7/2012, which affirmed the New Delhi Declaration and adopted the 2012 Sofia Guiding Statements on the Judicial Elaboration of the 2002 New Delhi Declaration of Principles of International Law Relating to Sustainable Development, *available at* http://www.ila-hq.org/download.cfm/docid/7C2F958B-C576-4C55-94F79F50A87AE74D.

[55] Almost half a century ago, Oscar Schachter stated thirteen possible bases of international legal obligation. The list of potential sources has since no doubt increased. Oscar Schachter, *Towards a Theory of International Obligation,* The Effectiveness of International Decisions 9-10 (Stephen Schwebel ed., 1971) (citing consent of states; customary practice; a sense of "'rightness'-the juridical conscience"; natural law or natural reason; social necessity; the will of the international community; "direct (or 'stigmatic') intuition"; common purposes of the participants; effectiveness; sanctions; "'systemic' goals"; shared expectations as to authority; and rules of recognition).

[56] *See* Harold Honju Koh, *Why Do Nations Obey International Law?* 106 Yale L.J. 2599 (1997) and Andrew T. Guzman, *A Compliance-Based Theory of International Law*, 90 Cal. L. Rev. 1823 (2002).

[57] New Delhi Declaration of Principles, *supra* note 53.

[58] *E.g.*, *Gabčíkovo-Nagymaros Project (Hungary/Slovakia), Judgment*, *ICJ Reports 1997*, 7 ss.; *Pulp Mills at the River Uruguay (Argentina v. Uruguay), Judgment, ICJ Reports 2010*, 14.

[59] The very concept of sustainable development is still awaiting even basic judicial definition. *See* Afshin A-Khavari and Donald Rothwell, *The ICJ and the Danube Dam Case: a missed opportunity for international environmental law?* 22 Melb. U. L. Rev. 507, 519-520 (1998).

1. The duty of States to ensure sustainable use of natural resources
2. The principle of equity and the eradication of poverty
3. The principle of common but differentiated responsibilities
4. The principle of the precautionary approach to human health, natural resources and ecosystems
5. The principle of public participation and access to information and justice
6. The principle of good governance
7. The principle of integration and interrelationship, in particular in relation to human rights and social, economic and environmental objectives

Of these, Principle 4, the precautionary principle, arguably has the most direct bearing not only on SUD[60] but also on a range of other applications of untried technological innovation.[61] This precautionary principle reverses the burden of proof: absent consensus in the scientific community that an action or policy is *not* harmful, a party taking or permitting the action or implementing the policy carries the burden of proof as to its harmlessness. Expectably, this principle has come under enduring attack by some as risk-averse, hostile to innovation, and a source of stagnation.[62]

On another issue, Porras has observed a growing global trend toward disintermediation of the city and its emancipation from the state with regard to its international dimension,[63] as at least some cities become notably internationalized while sustainable development initiatives are increasingly localized.[64] As international

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[60] Although refraining from terming it a norm of customary international law, due to the ICJ's failure to pronounce on it in *Gabčíkovo-Nagymaros*, the U.N. International Law Commission as the primary multilateral body for the codification and development of international law noted that the precautionary principle is "embraced worldwide." Pemmaraju Sreenivasa Rao (Special Rapporteur). Third report on the legal regime for the allocation of loss in case of transboundary harm arising out of hazardous activities, 58th Session of the ILC, UN Doc. A/CN.4/566 [24], (2006). *See also* Daniel Dobos, *The Necessity of Precaution: The Future of Ecological Necessity and the Precautionary Principle*, 13 Fordham Envtl. L.J. 375, 381 (2002). *Gabčíkovo-Nagymaros* did, however, recognize an international duty of care in conducting an EIA. *See generally* Erika L. Preiss, *The international obligation to conduct an environmental pact assessment: The ICJ case concerning the Gabcikovo-Nagymaros Project*, 7 N.Y.U. Envtl. L.J. 307 (1999).

[61] *See* Roberto Andorno, *The Precautionary Principle: A New Legal Standard for a Technological Age*, 1 J. Int'l Biotechn. L. 11-19 (2004) and Paolo F. Ricci, Dave Rice, John Ziagos, Louis A. Cox, *Precaution, Uncertainty and Causation in Environmental Decisions*, 29 (1) Envtl. Int'l. 1–19 (2003).

[62] *See generally* Noah M. Sachs, *Rescuing the Strong Precautionary Principle from its Critics*, 2011 (4) U. Ill. L. Rev. 1285–1338 (2011), and Alhaji B.M. Marong, *From Rio to Johannesburg: Reflections on the Role of International Legal Norms in Sustainable development*, 16 Geo. Int'l Env. L. Rev. 21 (2003). One of the sharpest criticisms of the principle was levelled by Cass R. Sunstein, *Beyond the Precautionary Principle*, 151 U. Pa. L. Rev. 1003, 1008 (2003), and *id., Your Money or Your Life*, New Republic, Mar. 5, 2004, 27, 30; *see also id., The Paralyzing Principle: Does the Precautionary Principle Point us in any Helpful Direction?* Regulation 33-37 (Winter 2002-2003).

[63] Ileana M. Porras, *The City and International Law: In Pursuit of Sustainable Development*, 36 Fordham Urb. L.J. 537, 559-563 (2009).

[64] *See also* Yishai Blank, *The City and the World*, 44 Colum. J. Transnat'l L. 875, 877 n. 1 (2006), and *id., Comparative Visions of Global Public Order (Part 2): Localism in the New Global Legal Order,*

consortia and multilateral banks have stepped up direct lending to cities without sovereign guarantee,[65] and trends such as decentralization and subsidiarity gain political momentum, urban legitimacy now more closely correlates with the higher degree of participatory democracy cities offer.[66] Privatization stands a greater chance of yielding cost benefits in cities because large pools of cheap and mobile labor can be accessed there.[67] At the same time, though, Frug and Barron argue that the city is becoming disempowered by the international community as the latter asserts a growing direct regulatory role over system-relevant urban settlements under changed concepts of governance.[68]

Notably, SUD is an area where, despite initial reservations, NGOs have been welcomed and advanced over the last three decades as representative players articulating in a legitimate fashion the authentic voice of global citizenry when it comes to cities as people's 'chosen community.' NGOs, rapidly proliferating and increasingly sophisticated in many areas and funded by an increasing variety of highly divergent and sometimes diametrically opposed sources and forces, have become able and accepted as representative actors advocating for the public interest[69] in the previously hermetic forum of international law that was narrowly defined as a 'sovereigns only' domain for most of its existence. Similarly, transnational associations of cities and local governments have now emerged as forces of significant impact in the international discourse.[70]

8. Changing Models of Organization and Leadership

New and important dynamics are at work in business organizations today, more so in technology-driven companies than in others. In the knowledge economy, there appears to be a law that empowerment of individuals always happens at the expense of organizations,[71] be they political parties, churches, unions, or corporate structures. The strength of such traditional organizations lay in centralizing in-house

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47 Harv. Int'L L.J. 263 (2006), Gerald E. Frug & David J. Barron, *International Local Government Law*, 38 Urb. Law. 1 (2006); Hari M. Osofsky, *Defining Sustainable Development After Earth Summit 2002*, 26 Loy. L.A. Int'l & Comp. L. Rev. 111, 116 (2003).

65 Porras, *supra* note 63, at 539 n. 6 (referring to the international community as consisting of UN, World Bank, Organization for Economic Co-operation and Development, and EU).

66 George A. Bermann, *Taking Subsidiarity Seriously: Federalism in the European Community and the United States*, 94 Colum. L. Rev. 332, 405 (1994) (addressing whether subsidiarity increases public participation).

67 Gerald E. Frug, *City Services,* 73 N.Y.U. L. Rev. 23, 88 (1998).

68 Gerald E. Frug & David J. Barron, *International Local Government Law*, 38 Urb. Law. 1 (2006).

69 Steve Charnovitz, *Nongovernmental Organizations and International Law*, 100 Am. J. Int'l L. 348, 348 (2006).

70 Judith Resnik, Joshua Civin and Joseph Frueh, *Ratifying Kyoto at the Local Level: Sovereigntism, Federalism, and Translocal Organizations of Actors (TOGAS),* 50 Ariz. L. Rev. 709 (2008). *But see* Duncan B. Hollis, *Why State Consent Still Matters – Non-State Actors, Treaties, and the Changing Sources of International Law*, 23 Berkeley J. Int'l L. 137, at 146-155 (2005)(arguing for restraint with regard to over-interpreting aspirational nonbinding action).

71 Liam Magee, Andy Scerri and Paul James, *Measuring Social Sustainability: A Community-Centered Approach.* 7 (3) Applied Research in the Quality of Life 239–61 (2012).

functions and routing processes through them. Whatever advantages a large private or public organization still maintains, it derives from the collective brainpower of all its increasingly highly-educated and trained members. The star system of executives is on the wane,[72] along with Frederick Winslow Taylor's scientific management process. Any function that can be automated will be, for reasons of both manpower and time efficiency. In many ways, business organization is starting to take on characteristics of swarm intelligence, much like beehives, ant hills, schools of fish, or flocks of birds.[73] This trend produces a workforce that has become too self-reliant, too independent, and undistracted by fear: a considerably less manageable workforce in the traditional sense. Even if management remains privy to more information, it can no longer claim qualifications or intelligence superior to its collective staff. Today's organizational leader is not a forbidding, mercurial figure but rather someone able to listen well, discern patterns, make analogies, and obtain organizational buy-ins.[74] Meaningful contributions are increasingly made by telecommuters from home. This by no means results in fewer hours spent on work, only in work hours spent in different arrangements and with different etiquette. Doing the best work possible is no longer tied to dress code and work place. Strengths and limitations of the organization are viewed differently—work is performed in a mobile, distributed, networked fashion by professionals moving between competitors with great ease and few regrets. Managing these new forces at the workplace will be crucial if ever-shrinking life spans of products, concepts, and management visions are to be harnessed in a sustainable, that is, a lasting way.

9. The Imperative of Fundamental Paradigm Change in Accounting Standards

Ultimately, sustainable development and the adjustments and prioritizations it axiomatically requires cannot be achieved without a comprehensive reform of accounting standards. But there, developments come *very* slowly.[75] Accounting reflects concepts of valuation and provisioning. Something that is not—and cannot be—reflected meaningfully in an accounting statement falls outside the scope of how we value and assess managerial, administrative, and policy-based achievement. A goal

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[72] Nicholas Carlson, *What Happened When Marissa Mayer Tried to be Steve Jobs*, N.Y. Times, Dec. 17, 2014, *available at* http://www.nytimes.com/2014/12/21/magazine/what-happened-when-marissa-mayer-tried-to-be-steve-jobs.html?_r=3.

[73] Carl Zimmer, *From Ants to People, An Instinct to Swarm.* N.Y. Times, Nov. 13, 2007, *available at* http://www.nytimes.com/2007/11/13/science/13traff.html?ei=5087&em=&en=2770422853e9f63e&ex=1195102800&pagewanted=print. *See also*, much earlier, Norbert Wiener, The Mathematics of Self-Organizing Systems. Recent Developments in Information and Decision Processes (1962).

[74] Tom Hayes, *Why so Many CEOs are Struggling Today*. Huffington Post, Dec. 29, 2014, http://www.huffingtonpost.com/tom-hayes/why-so-many-ceos-are-stru_b_6383634.html?ncid=txtlnkusaolp00000592.

[75] *See generally* Robert H. Herz, Kimberley R. Petrone, *International Convergence of Accounting Standards –Perspectives from the FASB on Challenges and Opportunities*, 25 Nw. J. Int'l L. & Bus. 631 (2004-2005).

not reflected in valuation[76] and accounting standards does not actually exist except as lip service; it may be meaningful as a concept on paper, but it is not 'real' where it counts: in day-to-day operational and financial decision making.

If, on the other hand, reformed accounting standards[77] are to reflect changed thinking in valuation, the consequences clearly will not end with their reflections in financial statements. This is where the challenge reaches its next level—and that is not an irresolvable problem, either: if value is created, it must be capable of some form of collateralization and alienation, or it is value without 'value as we know it.' The difficulties of pledging or executing against undeniably 'valuable' assets such as architectural design quality, clean air, fresh water supply, short commutes, urban farming, or aquaculture appear daunting only at first impression. But market-based innovative solutions have been found to exist for intangibles:[78] if value is what someone is prepared to pay for an asset, then there is a market for arts and antiques and all manner of collectibles despite their demonstrable inutility. No copyright exists, but billions of dollars in revenue are generated each year through performances of works of composers who have been dead for centuries. Valuation may be based on cost, market price, present or future income, share valuation,[79] or pay-off.

Might it be conceivable to pledge a superbly designed urban community and later evict its bankrupt population defaulting on its debts due to refusal of or reluctance toward reforms, without destroying the valued asset in the process? It is this sort of question that will require a substantive as well as procedural answer in an adjusted legal system. We must realize that without affirmative answers, we cannot have meaningful valuation and accounting reform. Without valuation and accounting reform, goals of sustainability will, in all likelihood, remain pipedreams. It is not more difficult to conceive of such solutions than it must have been for our parents' generation to imagine, much less accept, the far-reaching erosion of privacy and of the Bill of Rights brought about by the advent of the digital age.

10. Conclusion

SUD's many facets determining the quality of human life require advanced, case-appropriate use of multidisciplinary tools with substantial flexibility and sociopolitical sensitivity. Its challenges are not just quantitative in nature, resolvable

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[76] Paul Flignor and David Orozco, *Intangible Asset & Intellectual Property Valuation: A Multidisciplinary perspective.* Ipthought, WIPO Document 1 (June 2006) ("When you measure what you are speaking about and express it in numbers, you know something about it, but when you cannot (or do not) measure it, when you cannot (or do not) express it in numbers, then your knowledge is of a meager and unsatisfactory kind." Sir William Thompson, Lord Kelvin (1824-1907), *available at* http://www.wipo.int/export/sites/www/sme/en/documents/pdf/IP_Valuation.pdf).

[77] *See, e.g.,* John Patzakis, *New Accounting Reform Laws Push For Technology-Based Document Retention Practices,* 2(1) Int'l. J. Digit. Evid. 1 (2003).

[78] *See, e.g.,* Mikael Collan and Markku Heikkilä, *Enhancing Patent Valuation with the Pay-off Method,* 16 J. Intell. Prop. Rts. 377-384 (2011).

[79] James Lyons-Weiler, *Time for an IP Share Market? Direct Investment in Market-valued Intellectual Property Could Drive Translational Success.* The Scientist, Feb. 1, 2009.

by mathematical, logical, and scientific optimization, but also require value-based use of qualitative cybernetic instruments and sophisticated models based on systems theory[80] and systems analysis.[81] A superficial observation might conclude that these issues can be safely entrusted to a caste of technocratic policy wonks, but TA's scope reaches much further and requires adaptation not only of our legal reasoning but also of modern legislative and adjudicative procedures for substantially greater time-efficiency and suitability to increasingly complex technological tasks. Traditional forms of business organization evolved since the days of the East India Company are about to undergo more fundamental changes in style and substance of leadership than they have ever seen, for no other reason than for the dimensionally accelerated pace of technological change. It will also become necessary to revamp how we look at valuation and provisioning in accounting as well as in substantive law governing title (or, in the case of public goods, entitlement) to intangibles. Unless technology assessment proves capable of bridging not just the information, participation, and legitimacy gaps apparent today, Luddism,[82] as experienced from the Machine Breakers in Europe during the first age of mechanization *circa* 1811-1849 during the industrial revolution,[83] may pale before an anti-technology backlash driven by environmental concerns and income inequality. The current grass-roots movements surrounding, for example, GMOs, could prove but a foretaste of an Amish-style response to the concept of an advanced technology-based megalopolis.[84] It becomes clear that the economic and socio-political consequences of technology are so portentous, in some cases relative to the very survival of the human species as well as many others, that technology cannot be left to patent holders, patent trolls, investment bankers, industry groups, and their lobbyists, nor to a generally unreflective enthusiasm for free markets and the unfettered entrepreneurial spirit. This article or prudent practices developed in its subject matter does not advocate the opposite approach, but logic suggests that privatization of profits contrasted with socialization of multidimensional costs of delayed and potentially highly adverse consequences cannot be allowed to continue in light of the substantial and sometimes uncontrollable degree of leverage that contemporary technology can offer, particularly in its non-assessed or ill-assessed form. Without appropriate anticipatory solutions, sustainable human life might not survive in urban settings to articulate meaningful responses by remedial action.

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[80] Karl Ludwig von Bertalanffy, General Systems Theory: Foundations, Development, Applications (1968); *see also* Kristo Ivanov, *Hypersystems: A Base for Specification of Computer-supported Self-learning Social Systems,* C. M. Reigeluth, B. H. Banathy, & J. R. Olson eds., Comprehensive systems design: A new educational technology 81-407 (1993).

[81] Jeffrey Whitten and Lonnie D. Bentley, Systems Analysis and Design Methods, 7th ed. (2007).

[82] *See* Kirkpatrick Sale, Rebels Against the Future: The Luddites and Their War on the Industrial Revolution: Lessons for the Computer Age (1995).

[83] Eric J. Hobsbawm, *The Machine Breakers*, 1 (1) Past and Present 57-70 (1952). *See also* Karl Marx, Capital (1867) (vol. 1, ch. 15, sec. 1 discussing the strife between workman and machine).

[84] Steven E. Jones: Against Technology: From the Luddites to Neo-Luddism (2006).